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Various Observations. By W. Lassell, Esq.

"1856, July 28th, $11^h\ 40^m$ G.M.T. Turned the large equatoreal upon the planet *Juno,* and examined it with various powers, from 160 to 1018; but it did not bear the high powers well, and nothing like a *disk* could be seen. In colour it is certainly ruddy, but not so much so as a star of similar magnitude more south in the field, which is a good deal like it in character.

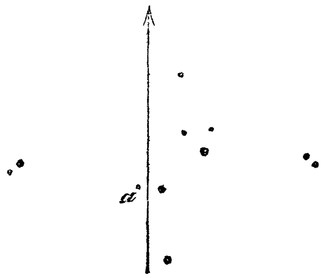
"July 30. Examined *Juno* again with various powers up to 1018, but could get no other image than what a fixed star of similar magnitude would give. It seems scarcely so red to-night, being just on the meridian ($12^h\ 20^m$): I should call it full yellow, or rather orange. There is an exceedingly minute star, nearly south, distant perhaps $20''$. *Juno* estimated 8½ magnitude.

"August 3. Scrutinised the planet for some time with 160, 565, and 1018, without detecting anything planetary about the disk; but it is curious that I again see a star, the faintest thing possible (with 24 inches aperture), in the immediate neighbourhood of the planet. Planet estimated to be barely so bright as the 8½ magnitude.

"August 31. Surveyed *Juno* for some time with single lens 479. On comparing the effect of magnifying power on this planet, and on neighbouring stars of similar magnitude, I cannot find that the light fades more on the planet, nor could I by any scrutiny of the planet's appearance distinguish it from a fixed star. The altitude of the planet, however (not 29°), is too low for this telescope and power. I do not detect any minute star near the planet to-night. Sky brilliant, but confused.

"*Comparison of Relative Efficiency of Prism and Plane Speculum,* which are considered to be of equal perfection of workmanship.

"July 30. About $11^h\ 20^m$ observed (not, however, for the first time) a minute star (a) north of the most following of the 'debilissimæ,' and about one-fifth of the way towards the northern double.



"I had then the plane speculum in the tube in bright condition; and as the sky was steadily bright and clear, I took out the plane speculum, and put in the prism, also in very good order. Powers 430 and 1018 were used in both instances; and I came to the conclusion that, though this minute point might be called the 'minimum visibile' with either plane, yet it was somewhat more constantly seen with the prism than with the speculum; especially with the lower power, which scarcely sufficed to show it steadily with the speculum. The superiority of vision, however, even with 1018, was not *striking,* though certain, and a very slight deposition of dew on the prism would suffice to neu-

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tralise the advantage. The speculum never sensibly collects dew. Therefore, it is only on objects of the last degree of faintness, such as the satellites of *Uranus* and *Neptune*, in this telescope, that the general superiority of the prism is apparent.

"November 28. In observing the satellites of *Uranus*, I could not make myself absolutely sure that I saw *Umbriel*, which is generally the faintest of them all, the plane speculum being in the tube. On putting in the prism, the suspected position of *Umbriel* was at once verified. The single drawback to the general use of the prism is its extreme liability to contract dew; and I have in succession resorted to various contrivances to obviate this annoyance. Both the plane specula and the prisms are mounted in boxes, so fitted with steady-pins entering holes in a plate permanently attached to the arm of the small metal, that, by the replacing of a single screw, any one of them can be instantly placed in perfect adjustment in the tube. This arrangement, permitting the examination or change of the prisms almost in a moment, with scarcely an interruption of observations, is highly convenient and even essential. After a trial of various modes of imparting just that increase of temperature to the prism, which shall prevent the deposition of dew, and yet produce no apparent disturbance of the rays of the image by radiation, from inequality of temperature, I finally adopted the following:—

"I made for the prism a triangular tin box, lined internally with wash-leather, only just large enough to contain it. When about to prepare for observation, I put this box in my pocket, close to my person; and by the time I have opened the dome, and pointed the telescope, I take out the prism and place it in the box, with the steady-pins before-mentioned; I then find that, even on a very dewy night, the prism will remain perfectly pure for upwards of two hours. Having a spare prism at the same temperature ready to substitute at the end of that period, only a very few moments are lost by the change. The larger boxes, which contain the prisms when in adjustment, are lined with thick *felt*, to prevent radiation; and I generally keep them at a temperature a little above that of the atmosphere, when about to be put into the tube, though not sufficiently so to feel warm to the hand. I would caution any one, using a prism, against leaving it in the tube permanently. To secure, I presume, the requisite high refractive power of the flint glass used for this purpose, so much lead enters into its composition, that it is by no means invulnerable by constant exposure to the deposition of dew, changes of temperature, and atmospheric action. Moreover, the glass is really much softer than crown-glass, and requires wiping always with caution, and the softest and purest material. A very soft and pure silk handkerchief, deposited in a tin box and kept for the purpose, I always employ. The prisms supplied by the Optical Institute at Munich require this care, and *deserve* it.

Deep-red Stars. "September 5. About 10^h 40^m, while sweeping about *Cygnus* and admiring, with power 160, the wonderful

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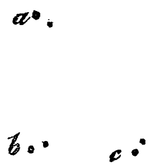
richness and splendour of the milky way, I discovered what appeared to me the deepest red star I have ever seen, magnitude $9\frac{1}{2}$, R.A. $21^{h}\ 16^{m}{\cdot}6$, N.P.D. 48° 13′. Many other stars are in the field with it.

"In R.A. $21^{h}\ 37^{m}$ N.P.D. 52° 42′ is another deep-red star rather brighter, 8th magnitude.

Curious triple-double Star. "In R.A. $21^{h}\ 28^{m}{\cdot}4$, N.P.D. 58° 36′ is a singular group of three stars, each attended by a small companion. The three principal stars form a right-angled triangle, with one side about one-fifth shorter than the other. Calling the star at the most acute angle *a*, and the others *b* and *c*, *a* is rather brighter than the 10th magnitude, *b* and *c* the 11th magnitude, a^2 the 11th, b^2 and c^2 the 12th magnitude. These magnitudes have been determined on the principle of the 'Photometrical Method of measuring the Magnitudes of Stars,' described by the Rev. W. R. Dawes in the eleventh volume of the *Monthly Notices* of the Royal Astronomical Society—a very able paper, which so far as I know has not yet received the attention it deserves. I have not myself, for want of opportunity, verified it by as many observations as I could wish, but I have come to the same conclusion very nearly, with regard to the aperture of a Newtonian telescope required to show a standard 6th-magnitude star; and *that* once determined, Mr. Dawes's method of ascertaining other magnitudes from that standard is extremely rational and simple. But in desiring to ascertain quickly, and with at least sufficient accuracy, the magnitude of a new star found in sweeping, to which some interest may be attached, a good deal of time is lost in trying on different diaphragms in order to ascertain that aperture which will just steadily make the star visible (to say nothing of the great number and variety of diaphragms required in doing this). I have therefore applied an apparatus to the end of the tube of the finder of my large equatoreal, which I find extremely convenient, and which, for magnitudes less than the finder will suffice to show, may be applied to the larger, or indeed any other telescope. My finder is a Newtonian reflector of 4·30 inches aperture and 42 inches focal length, with a magnifying power of 32 times. The end of the tube will just include a square of 3 inches in the side, inscribed within it. I have, therefore, a cap fitting on the end of the tube, out of which such an aperture is accurately cut. At right angles to a diagonal of this square, and at a distance from each other equal to the length of the diagonal, are two cheeks of a dovetail, between which a rectangular plate of metal slides, so that any part of the square can be shut off, and by a graduation on two sides of the square, the exact area exposed can almost without calculation be immediately ascertained.*



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* Mr. Lassell's MSS. contained a diagram of his apparatus, which the Editor has not thought necessary for the elucidation of his description. A paragraph or two has here been omitted. See page 83.

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"Where the determination of the magnitudes of rather small stars is a point of importance, such an apparatus as this might be applied to the object-glass of a refractor, the sliding plate being moved by a light rack and pinion attached to a Hooke's joint and long handle; thus obviating the extreme trouble and difficulty of getting up to the object-glass of a large telescope to change diaphragms. Magnitudes being often supplemental to the primary observation, any saving of time during a clear sky is of the highest importance; and in this method suggested, nothing more is necessary than to read the division on the graduated side of the square at the time, the resulting magnitude being ascertained afterwards at leisure. If to Mr. Dawes's column of lineal apertures a column of corresponding areas be added, the readings of this variable diaphragm may be compared with it by simple inspection almost without a calculation.

"*Close Satellites of Saturn.*—As observations of the nearest two satellites of this interesting planet are only within the scope of the highest class of telescopes, it may be of some interest to give an epoch or two of them.

"On the 6th of November, 1856, at about $13^h\ 20^m$ G.M.T. *Mimas* was seen as nearly as I can judge at his greatest elongation west, and on the 26th December about $11^h\ 50^m$, I observed him just past his greatest western elongation. The opportunities of seeing this minute and quick-moving body are extremely rare, for I have never seen it, or heard of its having been seen, when much removed from one or other of its elongations; and the short period of its transit over those parts of its orbit must occur when the atmosphere is in a fine state, and when the planet is favourably situated for observation. During the present very wide opening of the ring, this satellite is peculiarly difficult to see, and the more precise observation of an *opposition* or *conjunction*, I believe to be quite impossible in the present state of the telescope.

"*Enceladus* is easily seen in a good state of atmosphere in all positions, but I have not often caught it when optically at its precise conjunction or opposition. Such an epoch, however, occurred on the 1st December, when at $12^h\ 35^m$ G.M.T., *Enceladus* was apparently due south of the centre of the ball.

"*Satellites of Jupiter.*—1856, Oct. 5, $10^h\ 45^m$ G. M. T.—The satellites being well situated for comparison, I examined them with power 430. The second is apparently the smallest, the first and fourth seem equal in magnitude; the third is by much the largest. The intrinsic brightness of the first, second, and third, is nearly equal, but the fourth is decidedly less illuminated—indeed it has quite a dull appearance. All have good disks, but the air is moulding and will scarcely allow me to ascertain whether they are perfectly round. The third and fourth seem oval. The planet is very beautiful, but I despair to make a sketch of it. The cloud-like appearance of the principal northern belt is remarkable. A thin strip, north of this ample zone, is very dusky—about the same colour as the principal southern belt: but the very dark cap

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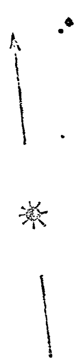
which enveloped the northern pole two years ago has quite disappeared. There are certainly chronic changes of great magnitude occasionally occurring on the face of this planet.

" μ^2 *Herculis.*—About two months ago Mr. Dawes drew my attention to this star, merely by the request that I would examine it and tell him 'what was the matter with it.'

"On the 11th November I pointed the telescope upon it with powers 260, 316, and 430. The faint, dull, and generally ill-defined appearance of the star presented a remarkable contrast to the brightness of its neighbour μ itself. On further scrutiny I perceived that μ^2 is double—unequally so, the small companion pointing a little to the north of the line joining μ^2 and μ. The wind was very keen from the north, and vision very bad.

"November 29th, 5^h 0^m G. M. T.—I surveyed the star again under much better circumstances, though it has now got so far into the twilight that it cannot well be seen until it is three hours past the meridian—a condition which the 20-foot telescope never fails to take cognizance of. I saw the duplicity of the star, however, much better than on the former occasion. The contrast of brightness between the minute-double and the principal star is so striking that the possibly planetary nature of the minute-double is forcibly suggested. It might be an earth and moon, dependent upon the principal star as its primary.



"The small double is a livid or faint purple colour, while the single star is brilliant yellow. I obtained measures of μ^2 from μ in position and distance: the mean gave—

Position, 244° 48′. Distance, 30″·62.

The small double, in Sir William Herschel's nomenclature, I should call very unequal—separated, with 316, nearly a diameter of the small star,—estimated position of the small one from the larger, 55°.

" *Trapezium in the Nebula of Orion.*—December 18.—Vision being very indifferent with the large telescope, I went into the smaller dome and turned the 9-feet equatoreal of nine inches aperture on this object, power 144, with which both the fifth and sixth stars are well seen (or rather *evidently* seen), for the air is much disturbed, though clear. The sixth star appears decidedly the brightest, or the largest, intrinsically, and if in the place of the fifth, would, I think, be more easily seen. Indeed it appears quite as plainly at present. Applied 200—the sixth is now certainly the plainest, and appears to me to be the largest star. But, generally, they are not so easily and instantly seen to-night with 200 as with the lower power. If these stars are unaltered in magnitude, I cannot understand why I should, many years ago, have so often scrutinized the fifth star with this telescope before I detected the sixth.

" *Occultation of Jupiter.*—1857, Jan. 2.—Air exceedingly

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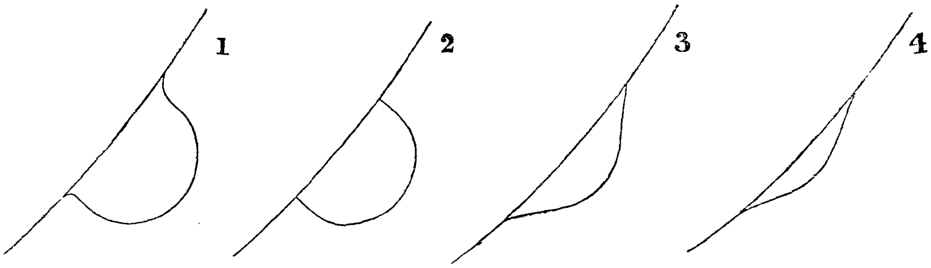
troubled. Wind high from S.W., wild sky, with clouds most undefined at their edges, and an under-stratum of scud. Immersion of the fourth satellite not observed. The third occupied about $2^{s}\cdot0$ from first contact until it was obscured. *Jupiter* himself was $1^{m}\ 48^{s}\cdot4$ in being occulted. The air was so extremely unsteady that neither *Jupiter* nor the Moon had a well-defined limb. Having directed my attention as carefully as possible to note the phenomena, I am certain that at least an ocular distortion of the planet took place.



" The annexed diagrams convey nearly my impressions of the alterations of form which took place at different periods of the immersion. When three-fourths occulted, the outline of the remaining portion of the planet was obviously that of a hyperbola, and could not be reconciled with the notion of a circular arc. The first and second satellites occupied less time in immersion than the third – as nearly as I could estimate, $1^{s}\cdot5$ and $1^{s}\cdot7$ respectively.

" Shortly after the immersion of *Jupiter* a violent gust of wind occurred, with a very slight shower, after which the sky became more favourable. I, however, missed the emersion of the fourth satellite, and the third was nearly its own diameter clear of the bright edge of the moon when I first saw it. The contrast of its brightness over that of the fourth, when in the neighbourhood of the moon, was most striking.

" The emersion of *Jupiter* was well observed, my eye catching the very first protrusion of its limb. The planet came out without any distortion that I could remark (except that I retain the faintest notion that when the disk was not more than a fifth part emerged, the arc of its circumference seemed to belong to a larger circle than that of the planet). The atmosphere had now become much more steady. The contrast of brightness of *Jupiter* and the moon scarcely seemed to me to be so great as it might be expected to be from the greater distance of *Jupiter* both from the sun and from us. The planet was certainly much paler than the moon, inclining by contrast to a greenish hue; but I doubt if it would appear so much fainter if placed in comparison with a piece of the moon of only the same size. The flood of light emanating from the moon impairs the sensibility of the eye, so that when the eye is directed to the planet, it looks pale; and as a proof, I found that when the moon's edge was kept only just within the field, the contrast

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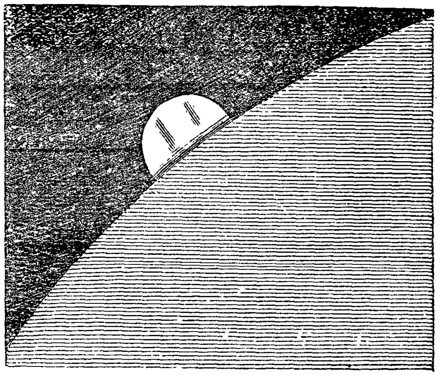
appeared to be less. The time occupied by the emersion of *Jupiter* was one beat of the watch less than was occupied by the immersion, viz. 1^{m} 48^{s}·0.



" But the most remarkable phenomenon of the occultation was that during the emersion, a shadowy line appeared projected on the planet from the edge of the moon, in character, magnitude, and intensity extremely like *Saturn's* obscure ring projected on the ball. The power with which this observation was made, 316, being much less than that with which I usually observe *Saturn*, I suppose that this penumbra was really broader, as it appeared to me to subtend about the same angle. With the exception that on the globe of *Saturn*, the projection of the obscure ring forms a line which is concave towards the opposite limb, whereas this projection from the moon's limb was convex towards *Jupiter's* preceding limb, I should pronounce the two phenomena to be identical in appearance; and whoever has seen the one will form a correct notion of the aspect of the other. I never saw this phenomenon before,—but I never before saw an occultation of *Jupiter* under circumstances so favourable and with so powerful a telescope. I think the planet had advanced one-third of its breadth from behind the moon before I noticed this line, —my attention was immediately and strongly drawn to it, and I watched it until close to the complete emersion of the planet without there being any variation of its appearance beyond a tremor or two from the atmosphere. The phenomenon was unmistakable, and I am satisfied there was no illusion.

" *Satellite of Neptune.*—During the most favourable position of *Neptune* the last autumn, the atmosphere was so generally cloudy here, or otherwise unfavourable, that I have scarcely any observations worth recording; however I send the few I was able to obtain.

		G.M.T.	Position.	Distance.	
		h m	° ′	″	
1856.	Sept. 4	12 19·5	210 46		(*a*)
		12 50·2	....	15·30	
	5	12 29·0	215 24	....	(*b*)
	Oct. 13	11 15·3	37 57	....	(*c*)
		11 2·3	....	17·93	
	19	10 39·5	40 28	....	(*d*)
		10 29·0	....	16·24	
	27	9 14·0	208 5	....	(*e*)

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REMARKS.

" (*a*) Wind strong from east, sky whitish and stars unsteady, yet the planet is brighter and better defined than I should expect under the circumstances. Measures of position good — those of distance pretty coincident, yet taken with difficulty. Power used, 614; which is the ordinary observing power for this object. Six measures of position taken — extreme difference, 3^{c} 4′. Five measures of distance taken— extreme difference, 1″·45.

" (*b*) The satellite seems about as far off as last night, or rather closer, but it is too faint to measure in distance satisfactorily.

" (*c*) Only three measures of position taken; extreme difference, 1° 34′, and three of distance; extreme difference, 0″·61. Observation considered good.

" (*d*) Satellite seen with great difficulty. Two measures only of position taken, differing 2° 7′; and three of distance; extreme difference, 1″·32.

" (*e*) Only a single measure of position could be got, and that with the greatest difficulty; much haze existing, and the atmosphere very confused. The satellite could barely be seen at intervals, and measures of distance were impossible.

" *Bradstones, Liverpool, 8th Jan.* 1857."

The Occultation of Jupiter on the 2d of January, as observed at Greenwich.

(*Condensed from the Report sent by the Astronomer Royal.*)

Mr. Main observed with the east equatoreal; Mr. Dunkin, with the north equatoreal; Mr. Ellis, with the 46-inch telescope, power 170; Mr. Criswick, with the telescope formerly belonging to the west equatoreal; and Mr. Lynn, with the altazimuth.

Mr. Glaisher's time observations have been omitted, the telescope used being but small. He remarks, " Nothing particular was observed."

Greenwich M. Solar Times by	M.			D.	E.	C.	L.
	h	m	s	s	s	s	s
Disapp., 4th Sat. first contact	4	44	4·5	...	...	...	...
Disappearance	4	44	5·5	5·7	5·7	14·2	4·2
3d Sat. first contact	4	51	41·1	...	...	...	...
Disappearance	4	51	43·1	42·9	42·9	44·0	43·1
Jupiter's first contact	4	58	33·5	33·8	33·8	32·8	35·0
Last contact	5	0	9·8	9·1	9·3	8·6	7·0
1st Sat. disappearance	5	1	0·6	1·4	1·4	0·4	1·0
2d Sat. first contact	5	2	13·4	...	...	...	...
Disappearance	5	2	14·2	14·2	13·7	13·2	13·1
Reapp., 4th Sat. reappearance		...		...	...	...	...
3d Sat. reappearance	5	49	66·1	46·4	...	...	...
Jupiter's first appear.	5	59	17·1	22·8	17·4	18·9	19·0
Last contact	6	0	52·8	51·6	47·1	48·6	46·8
1st Sat. reappearance	6	1	57·6	64·4	...	...	...
2d Sat. reappearance	6	3	44·3	48·1	42·1	...	47·3